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MENTAL MEASUREMENT.

1. *Mathematics and the material sciences rest upon quantity and measurement.*

THE history of science is the history of measurement. Those departments of knowledge in which measurement could be used most readily were the first to become sciences, and those sciences are at the present time the furthest advanced in which measurement is the most extended and the most exact. Mathematics is concerned entirely with number and quantity, and it has always been allowed a position more secure and permanent than the physical sciences. Mechanics holds a place in the hierarchy of the sciences next to pure mathematics, and mechanics consists of measurements and the relations of quantities. Physics, as its measurements are made more complete and exact, becomes mechanics. The late development of the biological sciences was due to the difficulties in the way of applying measurement to the living body. But each step in advance has consisted in overcoming these difficulties. As experiment and measurement are extended to the organism, biology becomes a branch of physics. We may affirm without hesitation that quantity is the beginning and end of material science.

2. *Increasing use is made of measurement in daily life.*

Clocks, balances, and foot-rules seem indispensable to our present civilization. Thermometers, barometers, lactometers, etc., are no longer looked upon as scientific instruments, and these and other means of measurement will soon be used by everyone. The applications of machinery and the development of the useful arts rest on the increasing use of mechanics and quantitive relations. The history of words used to express magnitudes bears witness to the progress of exact measurement.

The length of a human foot, a thousand paces, a field, an interval of time, a stone—these show how inexact were the originals of our foot, mile, acre, hour and stone. The artificial origin of second, minute, ounce, and inch indicates the late introduction of finer measures. Modern knowledge and ways of thought seem to depend more and more on quantity and measurement. We no longer speak of the boundless sea and the innumerable host of the Argives. We ask, how many? how much? Questions of matter of fact, such as may be answered by yes or no, are rather the presuppositions of science than science itself. Only facts which are newly discovered, or which are remote from common interest, are a part of science. The line between science and everyday knowledge is, indeed, continually shifting. The scientific discoveries of one generation become the common heritage of the next. Not only matters of fact, but also methods of measurement and their more important results take their place in the widening circles of common knowledge and daily life.

3. *Measurement has been but little used in the mental and social sciences.*

While everyone will admit the ruling place of measurement in the material sciences and in their application to the affairs of daily life, facts of mind and relations of men are commonly supposed to be outside the range of experiment and measurement. This point of view seems, indeed, to be confirmed by the history of the sciences dealing with such subjects. We are here concerned only with psychology. Students of physics and biology point out the necessity of measurement to science, and claim that as mental phenomena are not subject to measurement, psychology cannot become an exact science. They tell us only the brain may be studied by scientific methods. Students of philosophy, on the other hand, absorbed in the questions of speculative philosophy—What is the mind? What is its destiny and meaning?—are apt to look upon any attempt at measurement as trivial, if not profane. But it must be admitted that the material sciences, resting upon measurement, hold a much more secure position than psychology, resting upon casual introspection, anecdote, definition, and metaphysic. Indeed, speculative psychology is so largely taken up with things uncertain and unknown that it scarcely deserves to be called a science. We may well ask, what will be the end of this? Shall we ever have exact and systematic knowledge of mental phenomena? If so, will it be with or without measurement?

4. *Psychology may be following in the path of the material sciences.*

We have seen that as these advance, they depend increasingly on measurement and quantity. But they once consisted of careless observations and crude speculations. The psychology of the Greek philosophers was better than their physics and biology. Methods of experiment and measurement were but slowly devised and applied in the material sciences. Astrology and alchemy in their day were thought more important than astronomy and chemistry. It was once considered a satisfactory explanation to say that water rises in the pump because nature abhors a vacuum, or that a body is hot because it is filled with caloric. The interest in biology was once confined to stories of the phœnix and ant-lion, or in a search for simples and the elixir of life. Later, biology consisted of artificial classifications and dubious anecdotes and of medicine allied to quackery. It is only during the last forty years that vitalism is being slowly expelled from biology and scientific work is being slowly done in physiology and pathology. It seems still to be commonly held that the survival of the fittest explains the origin of the fittest. The history of the material sciences throws light on the present condition and future outlook of psychology. If Bacon sought to develop astrology, and Newton busied himself with alchemy, it is no wonder that some men of genius now-a-days take peculiar interest in telepathy, etc. If material science once consisted of definitions, anecdotes, and speculations, it is no wonder that these make up a large part of psychology at the present time.

Biology was of later development than physics, because it is easier to subject inert matter to experiment and measurement than the living body. But mental phenomena are more multiform, complex, transient, and obscure than those of the living body. It is natural, therefore, that psychology should be the last of the sciences.

5. *Mental phenomena are highly complex, but the phenomena of the physical world are not so simple as is commonly assumed.*

There are certain physical laws, those concerned with the attraction of gravitation, the dispersion of light, etc., which depend on the geometrical nature of space ; others, such as the indestructibility of matter and the correlation of energy, which depend largely on our sense of the fitness of things. Neither of these sorts of laws can be exactly proved by experiment, while it is likely that the first sort will be found to be inexact. We can, however, best consider the boundless complexity of nature by taking laws depending on measurements. Thus the experiments made by Boyle and by Mariotte discovered an apparently simple relation between the volume of a gas and its external pressure. More careful experiments showed that the law held only for certain gases and pressures. Still more exact measurements show that the law is only approximate, the relations between the volume of a gas and its external pressure being as numerous as there are gases, pressures, and temperatures. The movements of the planets may serve for a second example. By Copernicus their orbits were supposed to be circles and their motion uniform. Kepler discovered the less simple relations, which still serve as a convenient generalization. But it is evident that the relative motions of the planets are complex beyond the limits of measurement or mathematical expression. Students of physics are not discouraged by the difficulties involved in the undulatory theory of light, and students of biology continue to work over the intricate problems of heredity. Students of mathematics do not give up their science, because they are able to treat only a few equations amid an indefinite number. The complexity of both physical and mental phenomena is very great, but the order of the universe is perfect.

6. *Mental measurements must be of consciousness, not of the brain.*

The psychology with which this paper is concerned is not a part of physiology. Measurements of the mind, on the one hand, and of the body, on the other, may teach us that there is a complete correlation between the mental and the physical order. Should this correlation be established and its nature determined, it would be possible to measure either the physical or the mental phenomena, as might be found the more convenient. But the measurements to be treated here are of mental quantities or, at all events, of quantities which are functions of mental conditions. It seems, indeed, that our knowledge of the mind is less partial and uncertain than our knowledge of the nervous system. We have, for example, a considerable mass of fact and systematic knowledge concerning the nature and interaction of sensations. Starting from this knowledge, theories have been elaborated concerning the physiological processes in the eye and ear. The mental data are admitted by all, while the physiological hypotheses are in dispute. There is, again, some settled knowledge concerning feeling, attention, etc., whereas we are in absolute ignorance concerning the molecular changes in the brain which may accompany these mental processes. The advance of science will demand a more exact definition of the subject-matter of physics, of physiology, and of psychology, in which psychology must be allotted the measurements and quantitive relations considered in this paper.[1]

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[1] The writer does not agree with Professor James concerning the domain of psychology as a natural science, when he writes (*Principles of Psychology*, I. 182) "a blank unmediated correspondence, term for term, of the succession of states of consciousness with the succession of total brain-processes" is "the last word of a psychology which contents itself with verifiable laws." Mental processes are

7. *The magnitudes of physical science are, on the one hand, number and direction, and, on the other hand, time, mass, and distance.*

We are not here concerned with the metaphysics of these magnitudes, nor even with such critical discussion as may fall within the limits of a scientific theory of knowledge. Students of the physical sciences would disagree entirely as to such matters, and yet they coöperate everywhere in attempting to express the material world in terms of these magnitudes. As regards number and direction, it is evident that the units of measurement are given in the nature of things, and these units were used in the beginnings of science. As regards time, mass, and distance, the units of measurement are conventional, and are being slowly adjusted as science advances. Astronomy seems to have been the earliest of the sciences, and consisted at first of the relative positions and times due to the movements of the heavenly bodies. Distance was soon measured in surveying, architecture, and music. Mass was measured somewhat later, and the development of the idea of energy belongs to modern times. The question we have to consider is, whether there are mental magnitudes analagous to those of the physical world, and, if so, whether they may be measured and correlated. Is a mental mechanics possible?

8. *Number and statistics may be used in psychology.*

Number occupies a peculiar position, all measurement depending on ratios. The place of pure enumeration in the physical sciences has not perhaps been exactly defined. But it seems to be mostly unimportant, as when it is said that there

sui generis, and even though quantitive determinations were impossible, the laws governing the interaction and sequence of changes of consciousness could be determined apart from any question of the relation of mind to body. Aristotle might hold that the chief use of the brain is to supply the eyes with tears, and yet be a far better psychologist than M. Luys, who is considered an authority on the brain, but who writes: "Judgment is the principal operation of cerebral activity, etc. (*The Brain and its Functions*, 289.) Nor is psychology an art to "charm a chronic insane delusion away" (James: *Phil. Review*, I. 153). Professor James's Psychology would not be the important work it is, were it confined to the correlation of brain changes and consciousness, and the therapeutic value of hypnotism.

are seven colors or sixty-four elements. Enumeration is evidently possible in psychology. Thus the assumption of seven colors is mental, not physical. We are said to have five senses, because we are supposed to have five sorts of sensations, not because there are five sorts of sense-organs. The number of harmonious intervals in music is a true psychological constant. The number of equally noticeable differences between the minimum and maximum sensation may turn out to be an important constant. Attention has recently been called to moral statistics, and these are psychological measurements of a sort. Thus, it is something to know that, out of a million mothers, so many are infanticides. The lack of great scientific value consists in the fact that we do not measure or even define the conditions under which this percentage obtains. But if we find the percentage to be so much greater in winter or when the offspring are illegitimate, we are making some progress. There seems to be scientific value in the collection of statistics concerning the inheritance of mental traits, and in other directions. If we say that, when one idea suggests another, there are a certain number of classes among which all cases may be distributed, the distinctions are logical and the number of classes is not of much scientific importance. If, however, after the classes have been defined, we are able to determine the actual proportion of associations falling into each, we are making determinations of some value. If, further, the percentages are found to vary under fixed conditions, according to the occupation of the individual, for example, then such determinations have scientific interest. A still further advance is made, when we are able to correlate the frequency of an association with the time it takes. Here we have, indeed, the beginnings of a mental mechanics.

9. *The possibility of measuring time depends on the flow of individual thought.*

The motions of the heavenly bodies happen to be so well adapted for the measurement of time that most men will agree with Plato in his naïve assertion (Timaeus, 37), "God created time, and the parts of time — days, months, and years." But we cannot define time in terms of motion, when motion is defined in terms of time. If beings exist whose rate of thought is entirely variable, they have no science such as ours. If elsewhere in the universe there are rational beings whose rate of thought increases as the square of the time (terrestrial) during which they exist, they may have a system of mechanics, which would differ from ours in ways possible for us to calculate. It is true the intervals between certain physical changes are more constant than the intervals between thoughts, but this is a discovery made by using changes in thought as a standard of measurement. Indeed, the motions of physical bodies used to measure time are not so entirely accordant as is often assumed. There is no physical fact corresponding to the idea of uniform motion. A consciousness is conceivable to which the movements of the solar system are as irregular as the changes of the weather are to us. As the possibility of mechanics rests on the constancy of the rate of mental change, it is evident that this rate is sufficiently constant to admit of measurement.

10. *Length of life is measured by rate of thought.*

Should all our suns and pendulums begin to move faster and faster (time being measured by revolution of the siderial universe, and dynamical relations of space and mass being adjusted to fit), and all our thoughts and movements increase at the same rate, it would neither concern us, nor be noticed by us. Should our objective measures of time move faster, while the rate of physiological and mental change remain the same, we should live more days and years before we die, but none the longer. Should we live as many solar years as now, while the rate of thought and movement were increased, we should live so much the longer. The measurement of the rate of thought in the current units of physical science would seem, therefore, to be a matter of considerable interest. We need to know the time of physiological and mental processes, and the conditions on which variation depends. Such knowledge has not only theoretic interest, but has, also practical bearings in adjusting education, occupation, and mode of life. The measurement of mental time is proved possible by the measurements of mechanics, while its rate would seem to have as much theoretic and practical interest as the durations of any physical motions. Let us see what has actually been accomplished by experiment.[1]

II. *There is a time-threshold of consciousness, and the nature of a sensation depends on the time of stimulation.*

An impression must last a certain time in order that it may be perceived. Inertia and diffusion in the sense-organs and paths of conduction may partly account for this fact, but it can be shown by experiment that stimuli lasting too short a time to be distinctly perceived still affect the course of mental life. Such sub-conscious mental modifications should not be relegated to physiology; they may prove as fruitful for psychology as has been the study of sub-tangible phenomena for physical science. The time a stimulus must work in order that it may just be perceived, may be measured. Thus, it has been found that colors such as we see in daily life must work on the retina from about .001 to .003 sec., varying with the color and observer. If the time be shorter than this, no color is seen: as the time is taken longer, the intensity and saturation of the color increase, until, the time being about $\frac{1}{10}$ sec., a maximum is reached. As the time of stimulation is further increased, the intensity and saturation of the color decline and after a certain time disappear altogether. A similar relation obtains with the other senses. The noise and smells of cities are not noticed and cannot be fully perceived by those who dwell among them. The dependence of sensation on the time of stimulation may be represented by a curve, and its equation determined. The relation is of special importance as regards feelings of pleasure and pain. These soon reach a maximum and then decline. The Greeks might have called the gods pitiful as well as envious for both pain and pleasure consume themselves. If *fortune physique* is to be distributed so as to produce the maximum *fortune morale,* it should not be supplied continuously to one individual.

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[1] Prof. Ladd, who has accomplished so much for the advancement of experimental psychology, yet seems to the writer to betray a misapprehension of its domain when he writes (*Outlines of Phy. Psy.* 380) "We should be warned against imagining that researches in psychometry explain the origin or nature of our ideas of time." "Upon the origin and nature of this idea [succession] the so-called science of psychometry throws no light." In a text-book of astronomy there would scarcely be found such a statement as: "We should be warned against imagining that the so-called science of astronomy explains the origin and nature of of time."

12. *The time of physiological and mental processes can be measured.*

If the hand by accident touch a piece of hot metal, it will be withdrawn, but not before it has been in contact with the metal long enough to be burned. The time is, indeed, about $\frac{1}{10}$ sec. During this short interval a complex series of physiological processes must take place. The physical motion is converted into a nervous impulse, the impulse travels along the nerve and through the brain, a movement is released, the impulse travels back, and the muscle is innervated. The time required for such a reaction under varying conditions may be measured with great exactness. It is usually between one tenth and one fifth of a second, being longest in children, in the aged, and in disease. A reaction of this sort must be regarded as a physiological process, but it has psychological interest, as its length depends on mental conditions. Indeed, a reaction and its duration throw light on two of the most important problems before rational psychology — the nature of volition and the relation between body and mind.

13. *The time required for perception, movement, and thought may be measured.*

A simple reaction may be modified so as to include the time it takes to perceive a sense-stimulus or to choose a movement.

It takes about $\frac{1}{10}$ sec. to perceive a color and a little longer to recognize a picture or word. A word can be recognized as quickly as a single letter. A word is named more quickly than a letter, and much more quickly than a color or an object. The processes of perception and movement may be regarded as psycho-physical, but it is also possible to measure the time needed to remember, to form a judgment, and in the association of ideas. These times are purely mental; we know of them only on the side of consciousness, being in complete ignorance of the cerebral processes which may accompany them. It takes about $\frac{1}{4}$ sec. to translate words into a foreign language with which the observer is familiar, $\frac{2}{5}$ sec. to call to mind the language of a given author, $\frac{1}{2}$ sec. to multiply the numbers of the multiplication table, etc.; $\frac{1}{2}$ sec. is required to estimate the length of a given line or to decide which of two eminent men is thought the greater. The time required for one idea to suggest another under conditions similar to those of ordinary thought may be measured, and the times are of use in studying the laws of association. Psychology is a science, not an art, but time-measurements such as we have been considering have practical applications in æsthetics (as in the rhythm of music and poetry); in medicine (as in the diagnosis of diseases of the nervous system); in political economy (as in distributing wealth so as to secure the maximum amount of happiness), and in education (as in adjusting methods so as to increase the rate of thought).

14. *There is a least noticeable difference in intervals of time.*

Intervals of time may seem the same to common observation, while a difference may be readily measured with a clock. Savages living near the equator would not notice that days are longer in summer than in winter, nor do we notice the variation in the solar day. It is possible to measure the error made in comparing intervals of time, and to study its variation under varying circumstances. $\frac{3}{4}$ sec. has been found to be the interval, which can be most accurately perceived. An interval of time seems shorter when the mind is occupied than when idle, and to the old than to the young, and the quantitive relations can be determined. The accuracy and limits of the perception of intervals of time is an important factor in the composition and appreciation of music and poetry. The appreciation of intervals of time may depend on a rhythm of attention. The attention may be concentrated by an effort, but it will soon relax, and must be again concentrated only to relax again. These waves of attention seem to follow each other at constant intervals, and are an important factor in our mental life.

15. *If mental processes have only one magnitude, psychology cannot become a mathematical science.*

This was urged by Kant, who claimed that mental processes are extended in time only. If this be the case, it is evident that a mental mechanics is not possible. Astronomy could not be treated as "celestial mechanics," did it not measure the positions and masses of the heavenly bodies as well as the times of their movements. But Locke claimed that mental processes are not extended even in time,[1] and later writers may be mistaken in holding that they have no other dimension. Indeed it would be commonly admitted that sensations and feelings vary in intensity, but it is claimed that this intensity is not measurable. The measurement of mental intensity is certainly beset with greater theoretical and practical difficulties than the measurement of mental time. A starting point is found, however, in the fact that the intensity of a sensation is a function of the intensity of the stimulus, otherwise it would never have been discovered that one light is brighter, one sound louder, or one weight heavier than another. Even in physical science the brightness of lights and the loudness of sounds are only measured by the comparison of sensations.

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[1] Locke is not consistent in this matter, but he wrote (*Human Understanding*, Bk. 2, Ch. 9, 10), "for as itself [the mind] is thought to take up no space, to have no extension, so its actions seem to require no time."

Weight can be measured with great accuracy by the balance, but the balance is an invention like the clock. It was the need of weighing which led to the invention of the balance, not the balance which led to the discovery of weight. Apart from our sensations of varying intensity, physical science can only define weight in terms of size and density, density in terms of force, and force in terms of time and space.

16. *There is a threshold of intensity.*

When stimuli are very weak, they are accompanied by no distinct sensation. This may be partly a physiological fact, due to inertia of the sense-organ and nerve. But such stimuli may in certain cases be perceived by an effort and in other cases affect the course of mental life, although no amount of effort can call them to distinct consciousness. The intensity of a stimulus which can just be perceived (or perceived in a given percentage of cases) may be measured. This *minimum perceptible* is a function of the time of stimulation and of the degree of attention. Thus it has been found that the time a color must work on the retina in order that it may be just recognized, tends to vary as the logarithm of the intensity of the light. If we learn to measure the effort of attention, it may in like manner be correlated with the intensity of the stimulus which can just be perceived. It is, also, possible to compare the effects on mental life of stimuli too faint to be perceived with the effects of such as are distinctly perceived, and thus to correlate the intensity of sub-consciousness with that of consciousness.

17. *The error of observation is a function of the intensity of sensation.*

Stimuli may be so nearly alike in intensity that no difference can be detected by common observation. By proper methods the error of observation may be determined, and this is an important anthropometric test. It measures class and individual differences, and demonstrates the results of education, occupation, etc. The error of observation is found in most cases to become greater as the intensity of the sensation becomes greater. Thus we can distinguish (by lifting) 6 ounces from 5, but not 26 ounces from 25. When we determine the curve and equation representing the relation between the error of observation and the intensity of the stimulus, we define mental relations in the units of physical science. We can, again, determine the relation of the error of observation to the time of stimulation and to the time of perception, and the correlation of the time and intensity of sensation. Through the error of observation the rate at which a simple sensation fades from the memory may be measured. If we could do this one thing only, the possibility of a mental mechanics would be demonstrated. It is thought by Fechner and others that we can measure the intensity of sensation by means of the difference which can just be noticed. If this difference, as some experiments seem to show, is proportional to the intensity of the stimulus, and if it may be regarded as a unit for measuring sensation, it follows that the intensity of a sensation varies as the logarithm of the intensity of the stimulus. It is, further, possible that the intensity of a sensation, and more especially of an emotion, may be measured by the resulting or accompanying bodily movement.

18. *The intensity of pleasures and pains may, perhaps, be measured.*

In this case the just noticeable difference is a more likely unit than in the case of sensations, for even though the just noticeable change may not be an equal change at different degrees of intensity, it would seem to be an equally desirable change. Some approximation to the logarithmic relations seems, indeed, to hold as regards the intensity of pleasure, and the wealth which purchases certain pleasures. With an income of $1000, $1 will go about as far as $10 with an income of $10,0000. A man in public life would scarcely be affected by a newspaper notice which might give much pleasure or pain to a man in private life. Such facts must be taken into account by any economic theory which seeks to determine the best distribution of wealth. The relation between the duration and intensity of pleasures and pains seems to be of special importance. Supposing the intensity to remain the same, the amount of pleasure is directly measured by the time it lasts. Pleasures from disparate sources, *e.g.*, eating one's dinner comfortably at home or going out to a concert, may be more or less exactly compared by noticing which is habitually chosen. We can further (as is done in physics) define intensity in terms of time. If a pleasure (*e.g.*, eating a pear) last half as long as another (*e.g.*, eating two apples), and yet the two pleasures be regarded as equal (*e.g.*, to a child having five cents to spend and being in doubt whether to buy one pear or two apples) the former pleasure may be regarded as having double the intensity of the latter. Pleasures and pains are also correlated, as when one decides to attend an opera, knowing it will be followed by headache. Money spent in the purchase of pleasures lasting equal or commensurable times, measures roughly the intensity of pleasure, and (when money must be obtained by painful labor) correlates pleasures and pains.

19. *Extensity, if it be a mental magnitude, is still more obscure than intensity.*

It has been recently urged[1] with much force, that sensations must have a quality corresponding to the size of external stimuli. Attempts to explain the perception of space apart from such a quality in sensations, certainly seem unsuccessful. In any case there is a threshold of size as there is a threshold of time and intensity of stimulation. The area must be increased as the time and intensity are decreased, and the quantitive relations may be determined by experiment. Such determinations may also be made for sensation-areas on the skin. Objects nearly alike in size cannot be distinguished by common observation, and the error of observation may be measured as in the case of time and intensity. The correlation of the area of the stimulus with its intensity, and with the time of perception, may be determined through the error of observation. The perception of distance may be studied by similar methods, as, also, the perception of space by disparate senses. In the latter case apparently incommensurable sensations are correlated, somewhat as heat and mechanical work are correlated in physics.

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[1] By Prof. Stumpf in Germany, Prof. James in America, and Dr. Ward in England.

20. *Mental complexity may be analogous to the configuration of a physical system.*

We have seen that there are mental magnitudes corresponding to time, force, and space. But physical science is also concerned with the assemblage of relative positions of the parts of a material system, and the contents of the individual mind have at a given instant a certain complexity. Mental complexity and mental extensity (as their physical correlates) are closely related, the latter being perhaps an abstraction from the former. Whatever may be thought of these theoretical matters, certain experimental determinations must be acknowledged as valid. We can measure the amount which can be simultaneously perceived, — *e.g.*, 5 disconnected letters, 15 letters when they make words, and 30 letters when the words make sentences. Complexes at first sight incommensurable are thus correlated. We can also determine the time or the number of repetitions needed to learn a complex too large to be perceived at once, and the rate at which such a complex fades from memory. The complexity of the contents of consciousness is correlated with its intensity and clearness. The less we attend to, the more exactly can we attend to it. In addition to the contents of consciousness distinctly given, there is a penumbra of mental processes indistinctly recognized, and beyond this, it may be, a vast range of sub-conscious mental processes, which would account for memory, association, etc. It can be shown by experiment that a difference may be so small that it seems to the observer entirely imperceptible, and yet it will be correctly given by guessing more than half the time, or that an impression which entirely escapes consciousness the first time may become apparent by repetition. Sub-consciousness is thus correlated with distinct consciousness.

21. *The idea of mental extensity is important in ethics.*

Pleasures and pains differ not only in time and intensity, but also in extensity. More mental elements are involved in some feelings than in others. A pleasure (*e.g.*, eating) may be intense, but not extensive. Another (*e.g.*, doing one's daily duty) is not intense, but it is massive. An infant crying may suffer intense pain, in fact it is all pain, but the pain is not extensive because the mind is 'small.' With greater mental development the intensity of feelings may be less, but their extensity is greater. The idea of mental complexity throws light on the nature of emotions, in which some elements are in pleasure, some in pain. Through the phenomena of choice, and through our moral judgments, the extensity of pleasures and pains is correlated with their intensity, and duration. The greatness of a pleasure is the product of its extensity, intensity, and duration. What writers on morals mean by higher and lower pleasures is thus explained without mysticism. The idea of extensity of feeling reaches beyond the individual. Those pleasures (*e.g.*, creation in art and science, or love) are the greatest which affect many elements in the individual, and extend to other individuals, being at the same time intense and enduring.

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